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रॉक मास में दरारों के मात्रात्मक विवरण के  
तरीके  
भाग 9 सेट की संख्या  
( पहला पुनरीक्षण )

Methods for Quantitative Description  
of Discontinuities in Rock Masses  
Part 8 Number of Sets  
( First Revision )

ICS 93.060

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## FOREWORD

This Indian Standard (Part 9) (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Rock Mechanics Sectional Committee had been approved by the Civil Engineering Division Council.

A series of Indian Standard on test methods for assessing the strength characteristics of rocks and rock masses are being developed/revised in view of recent advances in the field of rock mechanics. The majority of rock masses, in particular, those within a few hundred metres from the surface, behave as discontinuous, with the discontinuities largely determining the mechanical behaviour. It is, therefore, essential that structure of a rock mass and the nature of its discontinuities are carefully described and quantified to have a complete and unified descriptions of rock masses and discontinuities. Careful field descriptions will enhance the value of *in-situ* tests that are performed since the interpretation and extrapolation of results will be made more reliable.

Discontinuity is the general term for any mechanical discontinuity in a rock mass, along which the rock mass has zero or low tensile strength. It is the collective term for most types of joints, weak bedding planes, weak schistosity planes, weakness zones, shear zones and faults. The ten parameters selected for rock mass survey to describe discontinuities are orientation, spacing, persistence, roughness, wall strength, aperture, filling, seepage, number of sets and block size. These parameters are also evaluated from the study of drill cores to obtain information on the discontinuities.

It is essential that both the structures of a rock mass and the nature of its discontinuities are carefully described for determining the mechanical behaviour. This Indian Standard, covering various parameters to describe discontinuities in rock masses.

This standard (Part 9) covers the methods for quantitative description of discontinuities in rock masses for number of sets. This standard (Part 9) was first formulated in 1987. This revision incorporates the latest advancement and modifications based on the experience gained in the use of this standard. The other parts formulated in the series are:

- |         |  |
|---------|--|
| Part 1  | Orientation                                |
| Part 2  | Spacing                                    |
| Part 3  | Persistence                                |
| Part 4  | Roughness                                  |
| Part 5  | Wall strength                              |
| Part 6  | Aperture                                   |
| Part 7  | Filling                                    |
| Part 8  | Seepage                                    |
| Part 10 | Block size                                 |
| Part 11 | Core recovery and rock quality designation |
| Part 12 | Drill core study                           |

Number of sets describe the number of discontinuity sets comprising the intersecting discontinuity system. The rock mass may be further divided by individual discontinuities.

The composition of the Committee responsible for the formulation of this standard is given in Annex A.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 2022 'Rules for rounding off numerical values (*second revision*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Indian Standard*

# METHODS FOR QUANTITATIVE DESCRIPTION OF DISCONTINUITIES IN ROCK MASSES PART 9 NUMBER OF SETS

*( First Revision )***1 SCOPE**

This standard (Part 9) covers the method for the quantitative description of the number of sets of discontinuities in rock mass.

**2 REFERENCE**

The standard given below contains provisions, which through reference in this text, constitutes provisions of this standard. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of this standard:

<i>IS No.</i>	<i>Title</i>
IS 11358 : 1987	Glossary of terms and symbols relating to rock mechanics

**3 TERMINOLOGY**

For the purpose of this standard, the definitions of terms given in IS 11358 shall apply.

**4 GENERAL**

**4.1** Both the mechanical behaviour and the appearance of a rock mass will be dominated by the number of sets of discontinuities that intersect one another. The mechanical behaviour is especially affected since the number of sets determines the extent to which the rock mass can deform without involving failure of the intact rock. The appearance of the rock mass is affected since the number of sets determines the degree of over break that tends to occur with excavation by blasting (*see* Fig. 1).

**4.2** The number of sets of discontinuities may be a dominant feature of rock slope stability, though

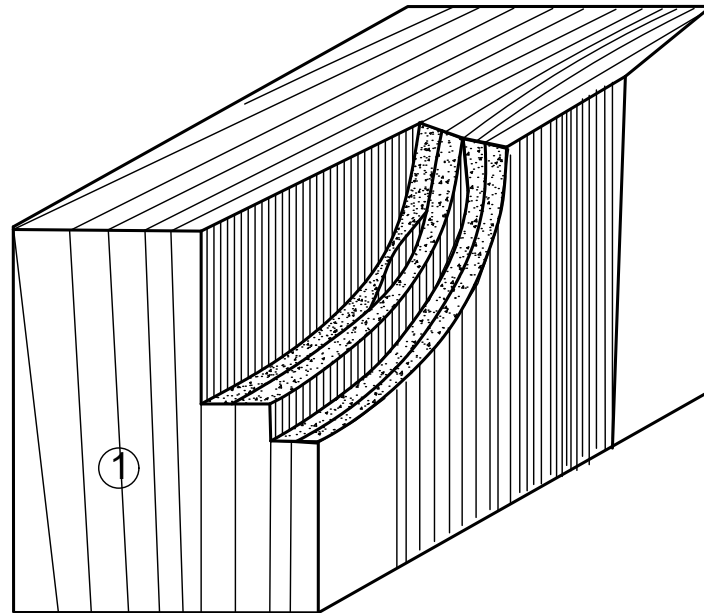
traditionally the orientation of discontinuities relative to the face is considered of primary importance. However, if sufficient sets exist the probability of instability may be reduced almost to zero. On the other hand, a large number of sets having close spacing may change the potential mode of slope failure from translational or toppling to rotational/circular.

**4.3** In the case of tunnel stability, three or more sets will generally constitute a three-dimensional block structure having considerably more 'degree of freedom' for deformation than a rock mass with less than three sets. For example, a strongly foliated phyllite with just one closely spaced joint set may give equally good tunnelling conditions as a massive granite with three widely spaced joint sets. The amount of over break in a tunnel will usually be strongly dependent on the number of sets.

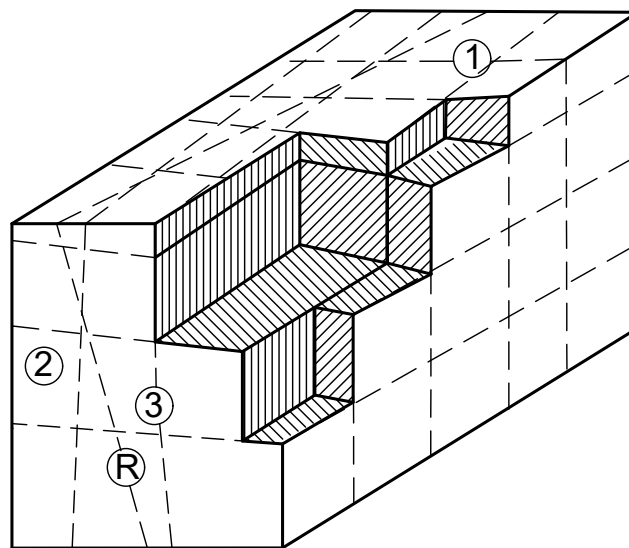
**4.4** The number of sets forming an intersecting system of discontinuities divide the rock mass and describe the appearance and form of the rock mass. The information is obtained from visual recognition during rock mass survey and/or study of photographic recording or rock exposure.

**5 PROCEDURE**

**5.1** The number of sets will often be a function of the size of the area mapped. In a preliminary investigation it is important to record all sets present. The recognition of individual sets will usually proceed simultaneously with the orientation measurements. Up to 150 discontinuity planes (joints) may need to be measured, and the number of sets can usually be determined by contouring discontinuity plane (joint) poles plotted on polar equal area nets.



ONE JOINT SET



THREE JOINT SET

FIG. 1 EXAMPLES THAT DEMONSTRATE THE EFFECT OF THE NUMBER OF JOINT SETS ON THE MECHANICAL BEHAVIOUR AND APPEARANCE OF A ROCK MASS

## NOTES

**1** Systematic discontinuity (joint) sets should be distinguished from non-systematic discontinuities (joints) when recording the number of sets. In general, systematic discontinuities (joints) will be persistent features, with individual discontinuities (joints) parallel or sub-parallel in plan, while non-systematic discontinuities (joints) display random rather than oriented patterns in plan and section. Problems of set identification when sets cannot readily be distinguished in the field may be reduced by utilizing statistical tests for identifying trends in the distribution of poles plotted on polar equal area nets.

**2** Incipient discontinuities such as those that may develop parallel to bedding, or parallel to foliation or cleavage, should be included in the local estimate of the number of sets, if it is considered that the method of excavation employed will sufficiently disturb the rock mass to cause development of these features into equivalent bedding joints, foliation joints, etc.

**3** The number of sets recorded will tend to be a function of the size of area mapped, and should be interpreted accordingly. The spacing of individual sets will play an important role in this interpretation. For example, four sets recognised following a 'conventional' survey of an area (using the pole contouring method) may include some sets with such wide spacing that these would be of little relevance to the stability of a short length of tunnel, though possibly of considerable importance to the stability of a major slope.

**5.2** If orientations are consistent, careful sampling may reduce the number of discontinuities (joints) that have to be measured to define the number of sets.

**5.3** In the detailed stages of field investigations, the number of sets present locally should be recorded as a supplement. The stability of a given section of

tunnel or rock slope, or the deformability of a given foundation will be a function of the relevant number of sets found locally, rather than of the total number mapped in whole area.

**5.4** Visual recognition of the number of sets should be accompanied by some system of numbering for identification purposes. For example, the most systematic and persistent set can be labelled 'Set No. 1' and so on (Fig. 1). Alternatively, sets can be numbered in the order of their importance to stability.

## 6 PRESENTATION OF RESULTS

**6.1** The number of joint sets present can be represented visually as part of the presentation of orientation data.

**6.2** The number of joint sets occurring locally (for example, along the length of a tunnel) can be described according to the following scheme:

- I massive, occasional random joints;
- II one joint set;
- III one joint set plus random;
- IV two joint sets;
- V two joint sets plus random;
- VI three joint sets;
- VII three joint sets plus random;
- VIII four or more joint sets; and
- IX crushed rock, earth-like.

Major individual discontinuities should be recorded on an individual basis.

**ANNEX A**

*(Foreword)*

**COMMITTEE COMPOSITION**

Rock Mechanics Sectional Committee, CED 48

<i>Organization</i>	<i>Representative(s)</i>
Indian Institute of Technology Roorkee	DR N. K. SAMADHIYA ( <b>Chairperson</b> )
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Amberg Technologies, Gurugram	SHRI KRIPAL CHOUDHARY SHRI RAKESH PANDITA ( <i>Alternate</i> )
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### Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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